Quantum Numbers

Rules of Electron Location and Orbital Filling Order

Heisenberg Uncertainty Principle

- It is impossible to determine both the **position** and the **velocity** of an electron at the same time.

Aufbau Principle

- An electron occupies the **lowest** energy level available.

Pauli Exclusion Principle

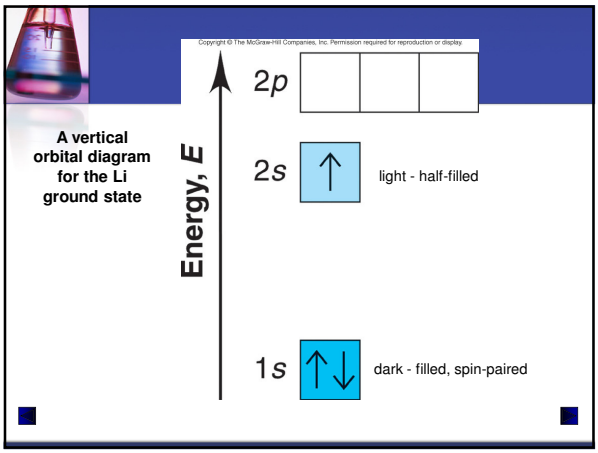
- No 2 electrons **in the same atom** can have the same 4 identical quantum numbers.
- In other words, no two electrons can be in the same place at the same time.

Hund's Rule

- Orbitals of **equal energy** are each occupied by **ONE electron** before any orbital is occupied by a **SECOND electron**
- All electrons in a single occupied orbital must have the same **spin**.

Orbital diagrams

- Shows each orbital as a box or line to be filled in.
- Follow order of filling.
- Hund's Rule – Don't pair electrons in degenerate orbitals until necessary.
- Unpaired electrons have the same spin.
- Pauli exclusion principle - two electrons can occupy the same orbital only by having opposite spin indicated by ↑ and ↓.



Principal Quantum Number

- Symbol = n
- Represents the main energy level of the electron
- Range = 1- 7
- Ex. = 3s

  Principal Quantum number = 3

Angular Momentum Quantum Number

- Symbol = l (small letter L)
- Represents the shape of the orbital (also called sublevel)
- Range = 0 – 3 (whole number)
- Shapes:
- 0 = s (sphere) 1 = p (petal)

  2 = d (double petal) 3 = f (flower)

Magnetic Quantum Number

- Symbol = m
- Represents the orientation of the orbital around the nucleus
- Each line holds 2 electrons

___ = s
0

___ ___ ___ = p
-1 0 +1

Magnetic Quantum Number (cont.)

___ ___ ___ ___ ___ = d
-2 -1 0 +1 +2

___ ___ ___ ___ ___ ___ ___ = f
-3 -2 -1 0 +1 +2 +3

Spin Quantum Number

- 2 Spin States
- Clockwise spin = +1/2 (upward arrow)
- Counterclockwise spin = -1/2 (downward arrow)

A Single orbital can hold two electrons, but they must have opposite spins

Quantum Numbers

- Pauli Exclusion Principle
  - No two electrons in an atom can have the same 4 quantum numbers.
  - Each electron has a unique "address":

1. Principal # → energy level
2. Ang. Mom. # → sublevel *(s,p,d,f)*
3. Magnetic # → orbital
4. Spin # → electron

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